

REMARKS

Claims 1-41 were previously pending in the application.

Claims 1-41 stand rejected.

Claims 32-35, 37 and 38 stand rejected under 35 U.S.C. 112, second paragraph.

Claims 1, 2, 8, 40 and 41 stand rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Pat. No. 6,042,652Hyun et al. ("Hyun").

Claims 3-7 and 9-26 stand rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Hyun.

Claims 27-31, 36 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hyun in view of Soininen et al. (U.S. 2002/0004293 A1).

Claims 2, 27 and 40 are amended.

New claim 42 is added.

No new matter is added.

With entry of this amendment, claims 1-42 remain in the case.

Reconsideration is respectfully requested.

Claims Rejections – 35 USC § 112

Claims 32-35, 37 and 38 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The rejection is respectfully traversed.

The Examiner states that, "with reference to claim 32-35, 37 and 38, applicants recite that the single atomic layer is an "oxide layer" (claim 32), a "composite oxide layer" (claim 33), a "nitride layer" (claim 34), a "complex nitride layer" (claim 35), a "silicide layer" (claim 37) and a "silicate material" (claim 38). This renders the claim indefinite since, according to independent claim 27, the single atomic layer comprises a metal."

Claim 27 is amended to recite "to form a single atomic layer by chemical exchange" to correct an editorial error. Thus, the rejection under 35 U.S.C. 112 is now overcome.

Claims Rejections – 35 USC § 102

Claims 1, 2, 8, 40 and 41 are rejected under 35 U.S.C. 102(b) as being anticipated by Hyun.

The rejection is respectfully traversed.

With respect to claim 1, the Examiner alleges that Hyun teaches, “providing a reactor (120) having a single reaction space.”

On the contrary, at col. 4, lines 52-61 of the Hyun reference, it is stated that:

“The reactor 120 is formed by assembling a plurality of modules 140 which can be disassembled as desired, having a plurality of openings A at one side of the assembly. Inner space of the reactor 120 is *partitioned* by the modules 140, resulting in a *plurality of stages* 114 each of which receive one semiconductor substrate 122 through the corresponding opening A.” (Emphasis added)

Accordingly, in Hyun, the reactor 120 is partitioned by the modules and, thus, has a plurality of stages, i.e., reaction spaces. In each of these reaction spaces within the reactor 120, the atomic layer deposition reaction occurs separately from the other reaction spaces. Thus, Hyun does not teach a reactor having a single reaction space, as recited in claim 1 of the present application.

Further, the Examiner states that Hyun teaches “loading a plurality of wafers (122) having a processing surface into the reaction space.”

The Hyun reference, however, merely states at col. 6, lines 57-64 that “a plurality of circular semiconductor substrates 122 are transferred *one by one* into the stages 114 through the openings A of the reactor 120.” Therefore, Hyun does not teach or disclose “*concurrently* loading a batch of substrates into the single reaction space of the reactor,” as recited in claim 1, because Hyun merely teaches one-by-one transferring of the substrates into the individual stages 114.

For the same or similar reasons, Hyun does not teach “concurrently loading the plurality of wafers having a processing surface into the reaction space, wherein the processing surfaces of the wafers face in substantially the same direction,” as recited in amended claim 40.

Additionally, with respect to claim 2, the Examiner also argues that Hyun teaches “diluting a non-chemically adsorbed portion of the first reactants in the single reaction space; diluting a non-chemically adsorbed portion of the second reactants in the single reaction space.”

However, Hyun nowhere teaches or suggests “diluting non-chemically adsorbed reactants in the single reaction space” for the following reasons:

According to an aspect of the present invention, which states at page 6, line 27:

“after introducing the first reactants 40, to effectively reduce the purging time, a non-chemically adsorbed portion of the first reactants 40 is *diluted* in the single reaction space 12 *before removal* of the non-chemically adsorbed portion of the first reactants 40 from the ALD reactor 10....the ALD reactor 10, as shown in FIG. 1, includes a pressure control valve 21 connected to an exhaustion line 25.... During the *diluting step* 33, the control valve 21 is substantially *closed* and an inert gas is *supplied* through input 16 into the reactor 10, and the introduction of the first reactants 40 into the ALD reactor 10 is substantially *stopped*.

....
Preferably, as illustrated in FIG. 2, during the dilution of the non-chemically adsorbed portion of the first reactants 40, the reactor pressure is increased from the first predetermined pressure P1 to a second predetermined pressure P2.

....
These steps allow the non-chemically adsorbed portion of the first reactants 40 in the reactor 10 to be diluted in a very short period of time, for example, a few seconds, thus drastically reducing the overall purging time and purging efficiency during a purging step 32 compared to conventional ALD techniques.”
(Emphasis added)

Thus, in the claimed invention, for example, as recited in claim 2, a diluting step is additionally performed before the conventional purging step, i.e., *removal* of the non-chemically adsorbed portion of the reactants from the ALD reactor. Also see FIG. 2 of the present application, which illustrates present invention purging steps 32, 26 including the diluting process in addition to the removing process, i.e., the conventional purging process.

In contrast, Hyun merely teaches the conventional purging process without the diluting process of the present invention. Specifically, the Hyun reference merely teaches, at col. 7 lines 15-27, the conventional purging step, which is no different than any other conventional purging step, as follows:

“After the single atomic layer is deposited, the gas supply portion 130 supplies a predetermined amount of purging gas through the inlet A1 of the first supply line 152 to the first buffering line 153, the pressure of the purging gas provided to the first buffering line 153 becomes *uniform* while flowing in the first buffering line 153, and the purging gas is ejected through the outlets B1 into the stages 114. While the purging gas flows on the substrates 122, the purging gas *purges excess first reaction gas* which remains after the deposition of the single atomic layer, out of the stages 114 through the openings A of the reactor 120. The purged first reaction gas is exhausted to the outside by a pump (not shown) connected to the vacuum chamber 110.” (Emphasis added)

Thus, Hyun nowhere teaches the diluting step in addition to the conventional purging step, for example, “before the removing, diluting non-chemically adsorbed reactants in the single reaction space,” as recited in amended claim 2. What is more, in Hyun, each reaction

space is much smaller than the reaction space of the present invention ALD reactor. Thus, there is no need for a diluting process in the Hyun invention. See page 6, line 27-page 7, line 3 of the present application.

Consequently, Hyun, lacking above limitations of the present invention, does not anticipate the invention recited in claims 1, 2, and 40. Also, claims 8 and 41, which respectively depend from claims 1 and 40 and recite features that are neither taught nor disclosed in the cited references, are allowable.

Claims Rejections – 35 USC § 103

Claims 3-7 and 9-26 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Hyun.

Claims 27-31, 36 and 29 are rejected under 35 U.S.C. 103(a) as being obvious over Hyun et al. ('652) in view of Soininen et al. (U.S. 2002/0004293 A1).

The rejections are respectfully traversed.

With respect to claims 3-7, which depend from allowable claims 1 and 2, because Hyun does not teach all of the limitations of claims 1 and 2, the Examiner has failed to make a *prima facie* case of anticipation or obviousness. Further, as stated above, Hyun teaches that “the pressure of the purging gas provided to the first buffering line 153 becomes *uniform* while flowing in the first buffering line 153,” and “the purging gas does not affect the internal pressure of the reactor 120.” See col. 7, lines 15-21 and lines 52-60; and col. 8, lines 12-24.

Thus, Hyun does not teach or suggest, “said introducing the gas containing reactants is performed at a first predetermined pressure and said diluting is performed to a second predetermined pressure, and wherein the second predetermined pressure is greater than the first predetermined pressure,” as recited in claim 3.

Therefore, claims 3-7, which depend from allowable claims 1 and 2 and recite features that are neither taught nor suggested in the cited references, are allowable.

With respect to claims 9-26, for the reasons discussed above, Hyun does not teach or suggest, for example, “diluting non-chemically adsorbed reactants in the reactor such that the pressure of the reactor is increased to a second predetermined pressure; and removing the diluted non-chemically adsorbed reactants from the reactor,” or “diluting non-chemically adsorbed reactants in the single reactor to a second predetermined pressure; and removing the diluted non-chemically adsorbed reactants from the single reactor, wherein said second predetermined pressure is greater than the first predetermined pressure.”

Accordingly, independent claims 9 and 16 are allowable and dependent claims 10-15 and 17-26, which respectively depend from claims 9 and 16 and recite features that are neither taught nor disclosed in the cited references, are also allowable.

For example, Hyun does not teach or disclose "providing a more than one hundred semiconductor substrates into a reactor." In Hyun, it is stated that "the stages 11 of the reactor 120 are constructed by assembling five modules 140 so as to receive four semiconductor substrates 122." In Hyun, however, if more than hundreds of substrates are to be received in a reactor, the reactor needs more than hundred modules each having separate supply lines, e.g., element 150 of FIG. 3 of Hyun, which is very costly and cumbersome. The temperature and pressure distribution would be extremely difficult to be uniformly maintained.

Also, in Hyun, as discussed above, because semiconductor substrates are transferred one by one, i.e., serially rather than concurrently, into the reaction spaces, the whole loading process takes a long time to load more than hundreds of substrates, significantly reducing the throughput. Thus, Hyun would not teach or suggest, "providing a more than one hundred semiconductor substrates into a reactor." See the specification at page 6, lines 7-18 of the present application.

Also, although the Examiner alleges Hyun inherently teaches pressure changes by adding or removing gas from the reactor, because Hyun merely teaches maintaining uniform pressure within the reactor or the pressure of purging gas becomes uniform, Hyun does not teach the pressure changes. Rather, Hyun teaches away from the present invention, because if the reactor pressure becomes uniform, it would not properly perform the diluting process as intended by embodiments of the present invention.

Further, in Hyun, if the exhaustion line is closed as in the present invention, the Hyun invention would not properly function because the pressure within the reactor should be uniform. Thus, in particular, dependent claims 14, 15, 17, 18, which recite, for example, "the reactor includes a pressure control valve connected to an exhaustion line and, wherein said diluting comprises substantially closing the control valve and supplying an inert gas into the reactor while stopping the introduction of the gaseous reactants into the reactor," "the reactor includes a pressure control valve connected to an exhaustion line and, wherein said diluting comprises supplying an inert gas with an amount substantially more than the amount of the gaseous reactants into the reactor while stopping the introduction of the gaseous reactants into the reactor," are allowable.

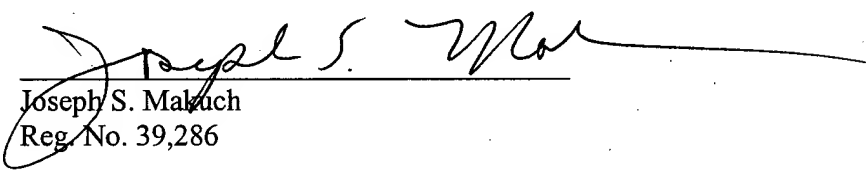
With respect to claims 27-31, 36 and 39, for the same or similar reasons discussed above, Hyun does not teach or disclose all of the limitations of claims 27-31, 36 and 39. Accordingly, the rejection does not present a *prima facie* case of obviousness. Thus, the rejection of claims of 27-31, 36 and 39 under 35 U.S.C 103 is improper. Therefore, claim 27-31, 36 and 39 are allowable.

New claim 42 depends from allowable claim 1, and adds a further limitation regarding non-partitioned single reaction space. No new matter is added, and it is submitted that claim 42 is allowable.

For the foregoing reasons, reconsideration and allowance of claims 1-42 of the application as amended is solicited. The Examiner is encouraged to telephone the undersigned at (503) 222-3613 if it appears that an interview would be helpful in advancing the case.

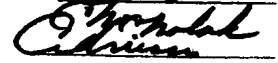
Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Please replace the paragraph at page 7, line 26, to page 8, line 2, with the following:

These steps [allows]allow the non-chemically adsorbed portion of the first reactants 40 in the reactor 10 to be diluted in a very short period of time, for example, a few seconds, thus drastically reducing the overall purging time and purging efficiency during a purging step 32 compared to conventional ALD techniques. This dilution process significantly reduces the partial pressure of the non-chemically adsorbed portion of the first reactants 40 in the ALD reactor 10. Thus, only a very small amount of the non-chemically adsorbed portion of the first reactants 40 remain in the reactor 10 after the removal of the non-chemically adsorbed portion of the first reactants 40 as the reactant 40 is already diluted, thus maximizing purging efficiency. Also, because the first reactants 40 are diluted, intermixing between the first reactants 40 can be sufficiently prevented.

IN THE CLAIMS

2. (Once amended) The method of claim 1, further comprising, [after introducing the gas containing reactants]before the removing, diluting non-chemically adsorbed reactants in the single reaction space.

27. (Once amended) An atomic layer deposition (ALD) method of forming a thin film layer, comprising:

- a) inserting one or more semiconductor substrates into a chamber;
- b) introducing a first gaseous reactant into a reactor at a first predetermined pressure, and chemically adsorbing a portion of the reactants on the surfaces of the one or more substrates;
- c) diluting non-chemically adsorbed first reactants in the reactor by injecting an inert gas into the chamber to increase the pressure of the reactor than the first predetermined pressure;
- d) removing the non-chemically adsorbed first reactants from the chamber;
- e) introducing a second gaseous reactant into the reactor at a second predetermined pressure to form a single atomic [metal] layer by chemical exchange;
- f) diluting non-chemically adsorbed reactants in the reactor such that

the pressure of the reactor is increased; and

g) removing the non-chemically adsorbed reactants from the chamber.

40. (Once amended) A method of forming a thin film, comprising:

a) providing a reactor having a single reaction space;

b) concurrently loading the plurality of wafers having a processing surface into the reaction space, wherein the processing surfaces of the wafers face in substantially the same direction;

c) introducing a first reactant into the reaction space, wherein a portion of the first reactant is chemically adsorbed on the processing surface of each of the plurality of wafers;

d) removing a non-chemically adsorbed portion of the first reactant from the reaction space;

e) introducing a second reactant into the reaction space, wherein a portion of the second reactant is chemically adsorbed on the processing surface of each of the plurality of wafers; and

f) removing a non-chemically adsorbed portion of the second reactant from the reaction space.

Claim 41 is new.